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Outcomes of reinterventions after subintimal angioplasty

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Objective: **With increased use of subintimal angioplasty (SIA), the role of reintervention after recurrence is currently unknown. To more clearly define the technical feasibility, patency, and clinical outcomes of reinterventions after SIA, we reviewed our cumulative experience.**

Methods: **A retrospective review of patient information (including demographics, indications, procedures, noninvasive arterial studies, and postprocedural events) was performed on those patients undergoing reintervention after a primary subintimal angioplasty in the infrainguinal vessels. Continuous and noncontinuous data were compared using the Student *t*-test and the z test, respectively. Patency was calculated by Kaplan-Meier analysis. Survival curves were compared using log-rank and Wilcoxon testing for univariate analysis and Cox hazard-regression analysis for multivariate analysis.**

Results: **From December 2002, through July 2006, 495 SIAs were performed for infrainguinal disease in 482 patients. Of this cohort, 121 patients (25%) required 188 consecutive reinterventions. Each patient underwent an average of 1.5 ± 0.8 (range, 1-7) reinterventions during this study. We analyzed only the outcomes of 124 consecutive, first reinterventions. Mean interval time between primary SIA and the first reintervention was 7.8 ± 6.8 months (range, 1 day-31 months). Indications for reintervention were clinical only (recurrence of symptoms or worsening exam), diagnostics only (recurrence based on peripheral vascular lab studies), or both in 18%, 25%, and 52% of patients, respectively. Technical success was achieved in 94% (n = 117) of the procedures. Repeat SIA technique was utilized in 68% (n = 84) of reinterventions and other endovascular therapies (32%; n = 40), of which the majority were transluminal angioplasty, for the remaining reinterventions. Mean follow-up was 8.6 months (range, 0-34 months). The patency rate at 1 year for the first reintervention was 33%. One-year patency rates for reinterventions performed within 3 months of the primary SIA were worse than those performed after 3 months (22% vs 34%; $P = .04$). In addition, patients treated for claudication had better 1-year patency than those treated for critical limb ischemia (37% vs 27%; $P = .03$). Other demographic or procedural variables did not significantly affect patency. In patients with critical limb ischemia (CLI), limb salvage rate at 1 year was 71%.**

Conclusion: **Endovascular reintervention after SIA is a safe and technically feasible procedure for recurrences and offers good limb salvage rate. Early reinterventions performed within 3 months of the original SIA portend a worse outcome. In addition, reinterventions are less durable in patients with CLI compared with claudication. Finally, by identifying a recurrent stenosis instead of an occlusion, close surveillance may contribute to improved overall outcome. (J Vasc Surg 2010;52:375-82.)**

Surgical and endovascular interventions are well-established therapeutic options for infrainguinal peripheral arterial disease. Limitations of open bypass surgery include surgical site infections and graft thrombosis. Graft thrombosis has been associated with higher costs and worse clinical outcomes.[1] Surveillance with duplex ultrasound has been used to maintain patency and improve outcomes for lower extremity vein bypasses.[2,3] Reinterventions to preserve open autologous surgical bypass grafts have been shown to improve overall outcomes.[1,4]

One of the limitations of endovascular interventions is its long-term durability, in which endoluminal restenosis or occlusions occur. Subintimal angioplasty (SIA) has been increasingly utilized for TransAtlantic InterSociety Consensus (TASC) C and D infrainguinal occlusions. Primary patency rates at 1 year have varied between 51% and 85%.[4-7] Our experience has shown a primary patency of 55% and 35% at 1 year and 3 years, respectively.[8] The outcomes of reinterventions after SIA failure are currently unknown, and very little if any data have been published. We reviewed our cumulative experience to more clearly define the technical feasibility, patency, and clinical outcomes of endovascular reinterventions after SIA failure.

MATERIALS AND METHODS

A retrospective review was performed on patients with critical limb ischemia (CLI) or disabling claudication who underwent a primary subintimal angioplasty from December 1, 2002 through July 31, 2006. Patient demographics, clinic notes, noninvasive vascular studies, angiographic findings, and operative reports were reviewed after approval by the Institutional Review Board.

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Competition of interest: none.

Presented at the Thirty-sixth Annual Meeting of the Society of Clinical Vascular Surgery, Las Vegas, NV, March 5-8, 2008.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a competition of interest.

0741-5214/$36.00

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doi:10.1016/j.jvs.2010.03.008

During this period, 495 limbs with infrainguinal arterial occlusive disease were treated with SIA in 482 consecutive patients. The occluded segments ranged from the superficial femoral artery to the tibial arteries. This study focuses only on those limbs in which a first-time reintervention was attempted after a prior, successful SIA was performed in the infrainguinal vessels; hence, evaluating results of 124 reinterventions on 121 patients. All procedures were performed in an angiographic suite. The common femoral artery contralateral to the treated limb was the preferred means of angiographic access. After angiography and identification of an arterial occlusion/stenosis, patients were systemically heparinized. The occluded or stenotic segments were typically approached by placement of a longer sheath over the aortic bifurcation and in proximity to the lesion. The endovascular technique utilized in each procedure was determined by the lesion. If there was a stenosis, every attempt was made to remain "intraluminal." Also, the characteristics of the lesion guided use of any other adjunctive therapies. If there was an occlusion, a repeat SIA was attempted. A soft, hydrophilic 0.035-inch guidewire in combination with a 4F or 5F angled hydrophilic catheter (Glidecath; Terumo Medical Corporation, Somerset, NJ) were the most commonly used to navigate through the stenosis or to perform a redo-subintimal dissection. After confirmation of traversing the lesion with a catheter into the true lumen, balloon angioplasty was used to dilate the area of stenosis or the new subintimal channel. Other adjunctive devices utilized during reinterventions included mechanical atherectomy (3), mechanical thrombolysis (2), thrombolytic infusion (5), cryoplasty (3), cutting balloon (2), and laser atherectomy (7). Only one patient underwent a combination procedure of cutting-balloon, angiojet, and tPA infusion. Self-expanding nitinol stents were selectively deployed within the treated lesions for: (1) suboptimal angioplasty, defined as residual stenosis greater than 30%; and (2) flow-limiting dissection flaps.

Technical success was defined as either the creation of a subintimal channel bypassing the occlusion, with successful re-entry into the true lumen and subsequent angioplasty or intraluminal therapy with a residual stenosis $\leq$30% after intervention. After the procedure, patients received clopidogrel for at least 1 month and aspirin indefinitely. Patients were allowed to resume ambulation 6 to 8 hours after the procedure and were typically discharged to home on the same day or within 24 hours.

Clinical follow-up at 1 month, 3 months, and 6 to 12 months after the procedure was routine and included physical examination and measurement of ankle-brachial indices. Duplex examination of the subintimal channel and further follow-up were obtained at the discretion of the treating surgeon. Any additional endovascular procedures to maintain or restore patency of the subintimal channel were recorded, as were all open surgical revisions, bypasses, and major amputations performed through July 31, 2007.

Patency of the SIA was defined by at least one of the following criteria: flow through the vessel demonstrated by angiography or duplex angiography (>50% stenosis defined by doubling of peak systolic velocity [PSV]), maintenance of an ankle-brachial index greater than 0.10 above the preprocedural value, or maintenance of a palpable pedal pulse that was absent before the procedure in an asymptomatic patient. Resolution of symptoms was not considered an indication of patency. Any follow-up intervention necessitating open surgical revision or bypass was reported as such and was not included in primary assisted or secondary patency. Only repeat endovascular procedures were included in calculating primary assisted and secondary patency rates.

Continuous data are expressed as mean $\pm$ SD and were compared by using the Student *t*-test. Noncontinuous data are expressed as percentages and were compared by using the z test comparison for proportions. $P < .05$ was considered statistically significant. Patency, limb salvage, symptomatic improvement, and freedom from surgical bypass were determined with Kaplan-Meier survival analysis and compared by log-rank and Wilcoxon testing. Multivariate analysis was performed by Cox proportional hazards regression. Patency is presented in terms of technical success.

RESULTS

Analysis of reintervention vs no reintervention. During this study period, 495 SIA for infrainguinal arterial occlusive disease were performed on 482 consecutive patients. Reintervention was performed in only 25% (124 limbs in 121 patients) of this population. The demographics for each group are displayed in Table I. The mean age at reintervention was 70 $\pm$ 11.6 years compared with 69.5 $\pm$ 12.5 years for no reintervention ($P = .65$). There were no statistically significant differences in risk factors between the two groups. The broad indications for the procedure were similar between the two groups (eg, presence of CLI in the reintervention [60%] vs no reintervention groups [63%; $P = .61$]). There was, however, a trend within the CLI category for more patients in the no reintervention group to have undergone treatment for gangrene than the reintervention group (14% vs 7%; $P = .055$). More patients in the no-reintervention group were treated for superficial femoral artery (SFA) only lesions than the reintervention group (41% vs 18%; $P < .01$). In contrast, more patients in the reintervention group were treated for SFA-popliteal lesion than the no reintervention group (62% vs 34%; $P < .01$).

Of the 371 patients in the no reintervention group, there were 89 who had loss of SIA patency. The outcomes of these 89 patients were progression to amputation (19), surgical bypass (28), death (6), and no measureable clinical end point (36). The patients who died or progressed immediately to amputation were poor operative candidates with CLI and tibial vessel disease. Half of the patients who underwent surgical bypass or no further treatments were claudicants. Only 1 of 16 patients with CLI who had a surgical bypass progressed to amputation.

A total of 33 surgical bypasses were performed in the no reintervention group. Twenty-eight were performed after loss of SIA patency as stated above. Five bypasses were performed in patent SIA without clinical improvement.

Table I. Patient demographics and risk factors for peripheral arterial disease

Variable	*Reinterventions (124 limbs; 121 patients)*[a]	*No reinterventions (371 limbs; 353 patients)*	P *value*
Age (y)			
Mean ± SD	70 ± 11.6	69.5 ± 12.5	.65
Range	41.8-97.5	36.8-98.9	
Gender			
Male	56% (68)	54% (189)	.61
Female	44% (53)	46% (164)	.61
Location of lesion			
SFA only	18% (21)	41% (154)	<.01
SFA-popliteal	63% (73)	34% (125)	<.01
SFA-popliteal-infrapopliteal	9% (11)	10% (39)	.60
Popliteal only	2% (2)	3% (10)	.50
Popliteal-infrapopliteal	4% (5)	4% (15)	.99
Infrapopliteal	4% (5)	8% (28)	.17
Indication			
Critical limb ischemia	60% (72)	63% (236)	.27
Rest pain	27% (32)	22% (83)	.43
Ulceration	26% (31)	27% (102)	.59
Gangrene	7% (9)	14% (51)	.055
Claudication	40% (49)	36% (133)	.46
Risk factors			
Hypertension	68% (92)	71% (251)	.30
Diabetes mellitus	50% (56)	51% (180)	.37
Coronary artery disease	53% (65)	53% (188)	.93
History of smoking	46% (59)	44% (157)	.41
End-stage renal disease	11% (13)	13% (47)	.46
Hyperlipidemia	35% (55)	38% (133)	.13
Previous LE bypass	27% (32)	20% (71)	.15
Nonoperative candidate	13% (16)	14% (51)	.74
Stent placement at primary SIA	25% (29)	22% (83)	.82

LE, Lower extremity; *SFA,* superficial femoral artery; *SIA,* subintimal angioplasty.
[a]Patient demographics calculated by number of patients; procedural characteristics calculated by number of limbs.

Analysis of first reinterventions. During the study period, 188 reinterventions were performed on 121 patients—hence, a mean of 1.5 ± 0.8 reinterventions per patient. Further analysis will only focus on the first reinterventions (124 interventions in 121 patients). The mean time to reintervention was 7.8 ± 6.8 months after primary SIA (Table II). At the time of reintervention, 61% (n = 75) of SIA channels were occluded, whereas the other 39% (n = 49) had one or more areas of restenosis. Patients with index SIA stents (17/29) had a similar percentage of occlusion at time of reintervention as those without a stent (59/95) at the index SIA (59% prior stent vs 62% no stent; *P* = NS). Redo SIA was performed on 84 limbs, whereas 40 limbs underwent intraluminal therapies. Being unable stay intraluminal, nine patients with stenosis underwent a redo SIA. These intraluminal therapies were predominantly balloon angioplasty (98%; n = 39); however, a few cases used adjunctive techniques such as mechanical atherectomy (1/40), laser atherectomy (3/40), cryoplasty (2/40), and/or tPA infusion (1/40). Stents were utilized more frequently at the time of reintervention compared to the time of primary SIA (45% vs 25%, respectively; *P* = .002). Also, stent use increased if the original SIA channel was occluded versus restenosis (51% [42/76] vs 21% [10/48]; *P* < .01). The majority of stents were placed in the superficial femoral and popliteal artery above the knee. There were 20 stents placed in the popliteal artery (five below knee), and three stents placed in a tibial vessel.

The majority of patients underwent reintervention based on a clinical and diagnostic study change (52%). Other reasons for reintervention were diagnostic study change ([decrease in ABI 0.1 or doubling of PSV on arterial duplex] only [25%]), clinical change ([failure to heal or loss of pulse] only [18%]), and acute ischemia (1%). Forty-five patients (36%) had ≤1-vessel runoff at time of reintervention, whereas 59 patients (48%) had ≥2-vessel runoff. Overall technical success was achieved in 94% (n = 117) of cases. A total of seven technical failures occurred during the study. Six failures were due to the inability to cross the lesion or re-enter into the true lumen; these patients proceeded to open bypass surgery. The other failure was due to an uncooperative patient; a successful endovascular procedure was performed at a later date. There were no statistically significant differences in technical success comparing the different techniques used, the prior use of stent, nor the status of the SIA channel at time of reintervention (occluded vs stenosis). Of the seven failures, only one proceeded to below-knee amputation 6 months later because of poor distal targets. The other six patients underwent femoropopliteal (1), femorotibial (4), and popliteal-peroneal (1)

Table II. Procedural details

Variable	*Data*
Time to reintervention	
Mean	7.8 ± 6.8 months
Range	0.03-30.72 months
Technique	
Redo SIA	68% (84)
Adjuncts	
Cryoplasty	1% (1/84)
Laser atherectomy	5% (4/84)
Mechanical atherectomy	2% (2/84)
Thrombolytic infusion	6% (5/84)
Mechanical thrombectomy	4% (3/84)
Cutting-balloon angioplasty	2% (2/84)
Other	32% (40)
Intraluminal angioplasty	98% (39/40)
Cryoplasty	5% (2/40)
Laser atherectomy	8% (3/40)
Mechanical atherectomy	3% (1/40)
Thrombolytic infusion	3% (1/40)
Mechanical thrombectomy	0% (0/40)
Cutting-balloon angioplasty	0% (0/40)
Reason for reintervention	
Acute ischemia	1% (1)
Clinical change only	18% (22)
Diagnostic study change only	25% (31)
Both (clinical and diagnostic)	52% (64)
SIA channel status	
Occlusion	61% (76)
Stenosis	39% (48)
Technical success	
Overall	94% (117)
SIA technique	93% (78/84)
Other technique	98% (39/40)
Previous stent	93% (27/29)
No previous stent	95% (90/95)
Stent placement at reintervention	45% (52)
Vessel runoff	
≤1	36% (45)
≥2	48% (59)

SIA, Subintimal angioplasty.

bypasses. Two patients who underwent bypass also proceeded toward below-knee amputations at 1.5 and 3 years later. In total, three of seven patients eventually required amputations. There were no periprocedural deaths at 30 days. There were four periprocedural complications (two emboli, one arteriovenous fistula, and one wire fracture), none of which required surgical intervention.

Mean follow-up was 8.6 months (range, 0-34 months). Primary patency after reintervention was 33% at 1 year (Fig. 1). Patients undergoing reintervention within 3 months of their primary SIA had worse 1-year patency rates than those with reinterventions after 3 months (22% vs 34%; $P = .04$; Fig. 2). Patients intervened upon for claudication had better 1-year patency than those intervened upon for CLI (37% vs 27%; $P = .03$; Fig. 3). There was also a trend for worse 1-year patency in patients with occluded SIA channel compared to those with stenosis (29% vs 37%; $P = .11$). Other demographic and procedural factors did not affect patency rates by univariate analysis (Table III). Multivariate analysis did not reveal any significant factors affecting patency (Table IV). Limb salvage for patients with CLI was 71% at 1 year (Fig. 4). Finally, survival at 1 year was 90%.

Twenty patients after reintervention required surgical bypass. Eight were performed for claudication, whereas 12 were performed for CLI (gangrene, 1; rest pain, 7; and ulceration, 4). One patient required an amputation 9 months after bypass. Sixteen patients, all of whom had CLI (41% [4/9] gangrene, 6% [2/33] rest pain, and 31% [10/32] ulcerations), required amputation after reintervention. Ten of the sixteen patients were nonoperative candidates, two of which had unsuccessful redo SIA. The remaining six patients presented with ulceration and required amputation at a mean of 8 months postreintervention.

DISCUSSION

SIA is an endovascular technique utilized for revascularization of TASC C or D lesions. Our group, along with many others, has increasingly used this technique for chronic arterial occlusions.[4,5,7,8] How to manage recurrence after SIA is currently unknown. Endovascular techniques have been used to salvage surgical bypass grafts with recurrent stenosis or occlusion. This study shows that endovascular reinterventions after SIA are safe, feasible, and provide good limb salvage in a difficult patient population.

During the study, only 25% of patients who underwent SIA required a reintervention. This percentage is similar to studies on reintervention for surgical bypasses, where approximately 15% to 20% undergo revision.[9-11] The mean time to reintervention, however, is much shorter for SIA at 7.8 months compared with surgical bypass at 12 to 15 months. There were no statistically significant differences in risk factors or disease classification in patients who underwent bypass versus reintervention. Our data for classification do not include a scale for severity. This is an interesting question that we are still trying to figure out clinically. Our paper shows that lesions located in the SFA-popliteal location require more reinterventions than those located solely in the SFA. This may reflect the complexity of the lesion or lesion length in the SFA-popliteal location. This study also shows a 1-year primary patency of 33% after reintervention. This patency is inferior to our previously published 1-year patency rates after index SIA cases of 55%.[8] Inferior patency rates after reintervention have also been seen in open and endovascular therapy for failing surgical bypass grafts.[1,9-11] These reinterventions, however, can provide good limb salvage and clinical outcomes without the cost and morbidity of open redo bypasses.[12,13] There are several reasons for inferior patency rates after reintervention. First, patients may have had continued progression of distal disease, which decreases outflow and may worsen outcomes. Second, the initial SIA channel may start up an inflammatory response leading to neointimal hyperplasia. Early recurrence may also be a marker for patients with worse disease or inflammatory response to SIA. Hence, these patients may have a predisposition to a worse outcome compared with patients without recurrence. Third, the creation of the index SIA chan-

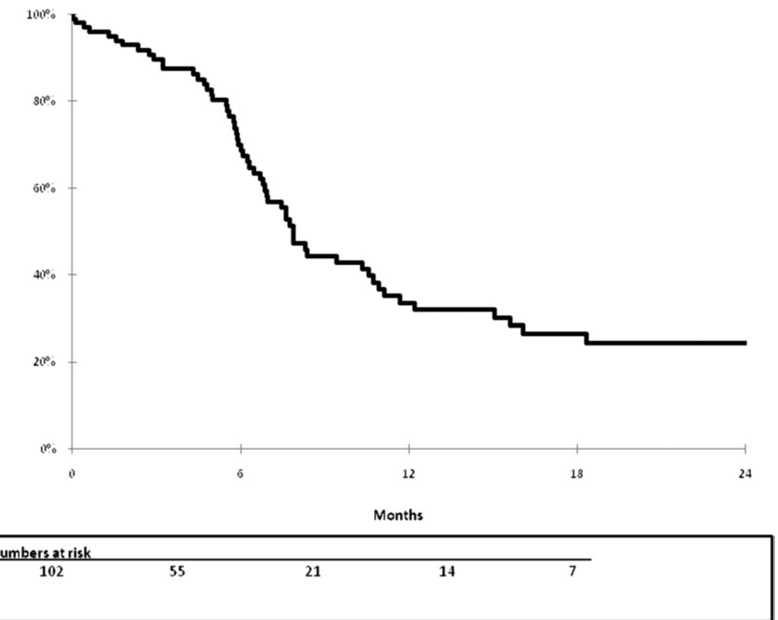

Fig 1. Primary patency after reintervention. One-year patency: 33%.

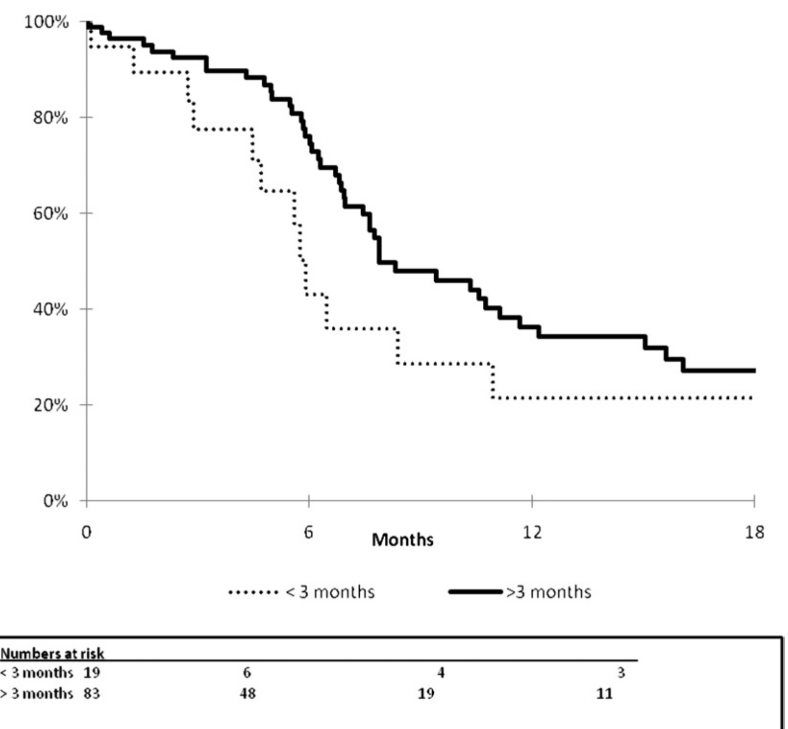

Fig 2. Primary patency after reintervention by time interval. One-year patency: ≤3 months 34% vs ≥3 months 22% ($P = .04$).

nel may have been very difficult, reflecting the severity of the disease in the vessel. This would be equivalent to a poor venous conduit. Therefore, any reintervention in a poor conduit would have an expected worse outcome. All of these components would make it more difficult to achieve an optimal result after reintervention.

Despite the low patency rate, limb salvage at 1 year remained very good for CLI patients. This limb salvage

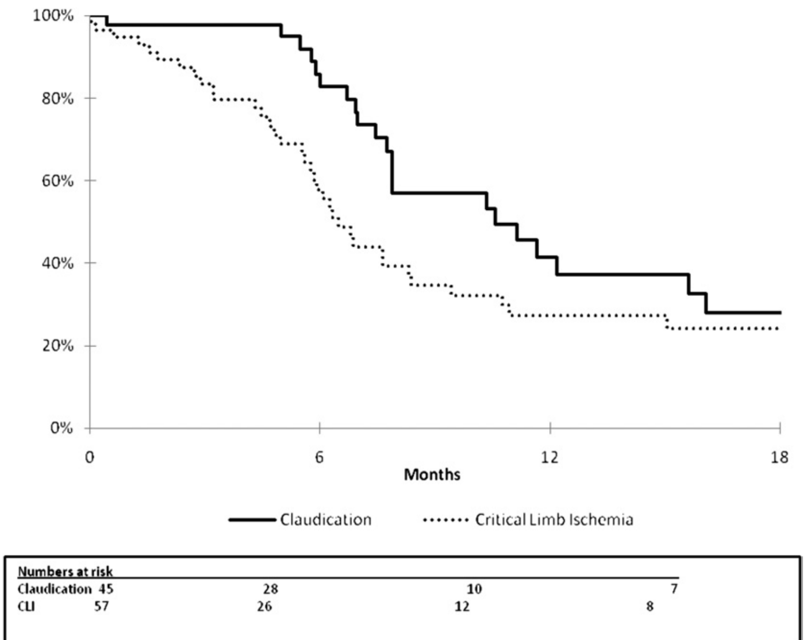

Fig 3. Primary patency after reintervention by indication. One-year patency: claudication 37% vs critical limb ischemia 27% ($P = .03$).

Table III. Univariate analysis of risk factors for loss of patency after reintervention

Risk factor	*Hazard ratio*	*95% confidence interval*	P *value*
Coronary artery disease	0.98	0.58-1.64	.93
Female	1.47	0.89-2.54	.13
African American	1.22	0.71-2.15	.45
Hypertension	1.04	0.56-1.92	.90
Age >80	1.54	0.87-3.11	.13
Smoking	0.79	0.47-1.32	.52
Hyperlipidemia	0.93	0.56-1.56	.79
End-stage renal disease	1.94	0.81-7.78	.11
Diabetes mellitus	0.79	0.47-1.32	.36
Prior bypass surgery	1.05	0.60-1.85	.85
Critical limb ischemia	1.75	1.05-2.94	<.05
Nonoperative candidate	0.53	0.27-1.32	.21
Previous stent	1.41	0.74-2.94	.27
Time interval <3 months	1.62	0.87-3.69	<.05
SIA status-occluded	1.52	0.89-2.55	.11
SFA-popliteal location	1.64	0.81-3.23	.18
No stent use	1.27	0.76-2.14	.37
Redo SIA	1.12	0.65-2.06	.68
Vessel runoff ≤1	1.15	0.65-2.06	.61

SFA, Superficial femoral artery; *SIA,* subintimal angioplasty.

rate, however, is less than that achieved by our index SIA (71% vs 87%).[8] This pattern of decreased limb salvage rate after reintervention has also been seen in open and endoluminal interventions after failing surgical bypass.[1,9-11] Technical success for reintervention was better than that for index SIA (94% vs 87%).[8] Only one patient required an outback catheter to achieve re-entry. This may be due to the previous subintimal channel allowing for an easier traverse of the lesion. In addition, all index SIAs are performed on chronic total occlusions, whereas reinterventions were performed for stenosis and occlusions in 40% and 60% of patients, respectively. Our approach for a redo SIA is the same as our approach to an index SIA. The important aspects for a SIA include a stable working sheath, which allows for good pushability and continued practice. The only possible differences between a redo SIA and index SIA are using a different wire and the amount of force. Interestingly, we did not find a difference in technical success if a stent was previously placed at the index SIA. In a previous article, we found that selective stents placed for suboptimal results after subintimal angioplasty produced similar patency rates to primary SIA without stenting.[14] This article shows that previous stent placement does not appear to affect the feasibility of reintervention. There were no cases of redo SIA channel outside a previous stent. Finally, these reinterventions were performed with no periprocedural (<30 days) deaths. Lower mortality has also been seen in endoluminal interventions for surgical bypass compared with open revisions.[9]

In our series, reinterventions for early SIA failures (≤3 months) have worse outcomes than for late failures (≥3 months). Interventions after surgical bypass have also had similar worse outcomes for early failure; however, early failure for surgical bypass is usually described as ≤6 months.[1,9-11] Early failure after SIA may reflect either more advanced disease, more severe inflammatory response, or inadequate initial procedure; hence, leading to a worse outcome after reintervention. This study also found a worse

Table IV. Multivariate analysis of risk factors for loss of primary patency after reintervention

Risk factor	*b*	*SE*	*Exp(b)*	*95% confidence interval*	P *value*
Occluded SIA channel	0.46	0.28	1.58	0.91-2.75	.11
Critical limb ischemia	0.51	0.30	1.66	0.93-2.97	.09
Time interval <3 months	0.27	0.34	1.31	0.67-2.97	.43

SIA, Subintimal angioplasty.

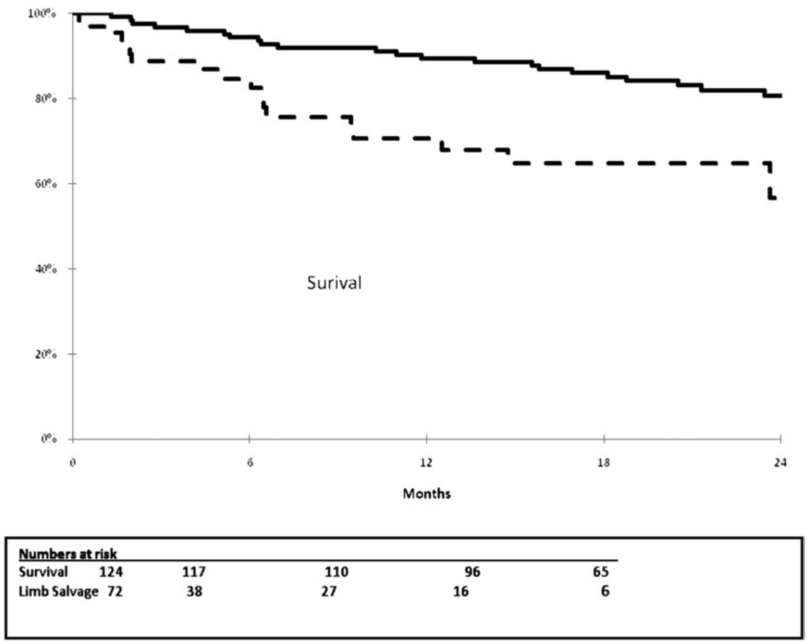

Fig 4. Limb salvage (*dashed line*) for CLI and overall survival (*solid line*) after reintervention. One-year limb salvage 71%; 1-year survival 90%.

outcome in reintervention for CLI. Our previous studies and others as well have also found worse outcomes in CLI patients after index SIA.[8,15-16]

Duplex ultrasound surveillance after open surgical bypass has shown improved long-term outcomes.[2-3] Part of this benefit is thought to derive from intervening on a lesion before graft occlusion. This study does not prove the value of surveillance after SIA; it does suggest better patency if reintervention on SIA channels are undertaken with stenosis versus occlusion. Interventions on surgical bypasses for occlusion have similar poor outcomes.[1,10] The important question regarding surveillance of SIA remains what to do with the result. If the patient is symptomatic with or without duplex changes, an angiogram with possible reintervention is warranted. The controversy lies within the patient who is asymptomatic but has a stenosis or occlusion on duplex ultrasonography. Out of 371 patients without intervention, 21 patients with loss of SIA patency and no symptoms did not progress to any further treatments. The follow-up period for this group is relatively short (~6 months). This may simply reflect the lack of follow-up with patients. Hence, no real conclusions can be made regarding the loss of a patent SIA without symptoms from this study. Whether reintervention will provide a better clinical or technical outcome is currently unknown at this time. Finally, our experience has also shown that SIA occlusion rarely leads to acute ischemia, unlike open bypasses (ie, "goes down softer"). The putative reasons may be preservation of collaterals or segmental occlusion of SIA channel compared with occlusion of the entire length of the bypass graft.[17]

Limitations of our study are several. First, its retrospective design contributed to incomplete data collection for some preprocedural and postprocedural variables. This could result in underestimation of patency based on clinical follow-up. Second, several different techniques were utilized for reintervention. In addition, this study included treated segments from the proximal SFA to the tibial vessels. This heterogeneous data could make interpretation of outcomes more difficult. This study, however, does reflect clinical practice in a difficult subset of patients. Third, there were no established selection criteria for reintervention. This makes it difficult to gain conclusions about which patients would benefit most and least from a reintervention. Finally, mean follow-up was relatively short, approximately 8 months. Therefore, this study cannot predict the long-term outcomes or benefits of reintervention after SIA.

CONCLUSIONS

Endovascular reintervention after SIA is a safe and technically feasible procedure for recurrences and offers a very good limb salvage rate. Early reinterventions performed within 3 months of the original SIA portend a worse outcome. In addition, reinterventions are less durable in patients with CLI compared with claudication. Finally, by identifying a recurrent stenosis instead of an occlusion, close surveillance may contribute to improved overall outcome.

AUTHOR CONTRIBUTIONS

Conception and design: GS, GM, GKS, JP
Analysis and interpretation: GS, AR, JP
Data collection: GS, ES
Writing the article: GS
Critical revision of the article: GS, JP
Final approval of the article: GS, JP
Statistical analysis: GS
Obtained funding: N/A
Overall responsibility: GS, JP

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Submitted Dec 19, 2009; accepted Mar 4, 2010.